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MICROBIAL METABOLISM AND ITS BEARING ON THE CANCER PROBLEM[1]

By Dr. A. J. KLUYVER

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SOON after receiving the invitation to speak here to you on a biochemical subject I had the good fortune to come across Dr. Ellice McDonald's most illuminating paper published in SCIENCE last summer.

His condemnation of the trial and error method in cancer research and his convincing plea for a study of cancer on the basis of cell metabolism made it seem to me possible to speak to you on some results obtained in the metabolism of unicellular micro-organisms. The more so because investigations of the last decade tend to establish to a quite unexpected degree the unity in metabolism of all living organisms, either microbes or higher plants or animals.

It needs hardly to be emphasized that micro-organisms lend themselves quite exceptionally for studies in cell metabolism. Since many of them are readily available in pure culture, it is quite possible to start at any moment experiments with a uniform biocatalytic material. Moreover, we owe to the genius of Pasteur the remarkable observation that several of the colorless unicellular organisms can thrive in a medium which contains only one single organic compound besides the necessary mineral constituents. It is clear that this circumstance simplifies the study of metabolism quite especially.

We have profited by this favorable situation to study the metabolism of several microbes in somewhat more detail.

In considering the metabolism of any living cell one is immediately struck by the remarkable fact that the compounds in the food are never integrally con-

[1] Lecture before the Cancer Research Laboratories, University of Pennsylvania, Graduate School of Medicine, on May 2, 1932.

verted into cell constituents. On the contrary, a large part of the compounds of the food leaves the cell again after having undergone a frequently profound chemical alteration.

It is obvious that this part of metabolism, the so-called dissimilation process, is best accessible for closer investigation. In doing so we soon recognize that the dissimilation processes of various microbes can be divided into two types: either in a slow combustion of the food substrate with the aid of free oxygen, *i.e.*, respiration in the more restricted sense, or to chemical conversions of one or more constituents of the food in which free oxygen plays no part. The latter processes are those which are generally designated as fermentation and putrefaction processes.

Whilst the respiration processes proper do not offer to the chemically trained mind special difficulties for their understanding this can not be said of the fermentation processes. Here we are only too often puzzled by the diversity of the products formed, the constitution of which not seldom differs to a noticeable degree from that of the substrate. Moreover, the relative quantities of these different products may vary markedly under the influence of the external conditions, under which fermentation takes place.

In the best studied fermentation process, *i.e.*, the alcoholic fermentation of sugars by yeast, the situation is relatively simple, since about 95 per cent. of the fermented sugars can be recovered in two products—carbon dioxide and alcohol in equimolecular proportions. Here we may conclude that the chief event which has occurred is a conversion of the glucose according to the equation:

$$C_6H_{12}O_6 \rightarrow 2\ CO_2 + 2\ C_2H_5OH$$

But what shall we think of fermentation processes, such as those that are effected by butyl alcohol bacteria, by *Bacterium coli*, by *B. aerogenes*, etc., where we observe the glucose to be converted into numerous products occurring in variable proportions?

However, a closer investigation of all these very complicated processes has made it extremely probable that all these obscure processes are in reality nothing but a chain of consecutive primary reactions, all of which present a common character in so far that they prove to be reactions in which hydrogen is transferred from one molecule to another, or from one part of the molecule to another part.

Moreover, there are good grounds to conclude that the same holds good for the respiration process proper on the understanding that here we meet with a coupled dehydrogenation and hydrogenation in which free oxygen acts as a hydrogen acceptor.

Finally, there is some evidence that we meet with exactly the same situation in assimilation, *i.e.*, in those metabolic processes which lead from the food to the formation of cell constituents, a formation which of course is the first condition for proliferation.

Lack of time forbids me to enter here into a discussion of the arguments which have led to the establishment of this conception. I can only invite you to accept for a moment our general conclusion[2] that we may summarize the essence of biochemistry in the scheme:

$$\begin{aligned} &\text{I} && AH + B \rightarrow A + BH \\ &\text{II} && AH.B \rightarrow A.BH \\ &\text{III} && AH.B \rightarrow A + BH \\ &\text{IV} && AH + B \rightarrow A.BH \end{aligned}$$

It will be clear that if we accept this view it must have an important effect on our general outlook on metabolic processes, more especially on our insight as to the way in which biochemical conversions are brought about.

Since all primary reactions do not proceed in the absence of the cell, we must conclude that the cell contains agents which act as catalysts for the reactions involved. We owe to Dubrunfaut the first experimental proof that it is possible to isolate such catalytic agents—enzymes, as they are called nowadays—from the cells. Moreover, it has proved possible to make from the same specific cells preparations which are able to promote different reactions out of the many of which these cells are capable. This has led to the conclusion that a living cell should be considered as an arsenal filled up with enzymes which successively are brought into action.

Now it is clear that such a supposition would only be justified if every chemical reaction brought about by the cell required its own specific catalyst.

It is not possible to give here due consideration to the problem of enzymatic specificity. It may suffice to remark that this problem, which is generally discussed in relation to hydrolases, asks for a special treatment so far as the agents of oxidoreduction, to which the name of oxidoreductases can be given, are concerned.

With a view to the enormous number of substrates which are liable to dehydrogenation under the influence of one and the same specific cell, as was clearly demonstrated by den Dooren de Jong, the doctrine of extreme specificity of oxidoreductases becomes untenable. For it can scarcely be conceived that the cells of a bacterium contain as many dehydrases as there are suitable respiration substrates for these cells.

Moreover, since amongst the dehydrogenation sub-

[2] *Cf.* A. J. Kluyver, "Chemical Activities of Microorganisms," London, 1931.

strates we also meet with compounds which do not occur in nature, like bromopropionic acid we can not escape the conclusion that in this case the same catalyst is capable of acting upon different substrates and very probably even on a large number of these.

Once accepting the presence of such dehydrogenating "master-keys" in bacterial cells, there seems to be no serious objection to go farther on this way of simplification and to assume that in every living cell there is only a single oxydoreduction promoting agent, which is responsible for all oxidoreductions effected by the cell.

Although these conclusions have been reached as the result of a critical analysis of microbial metabolism, it seems extremely probable that they apply as well to the cells of higher plants and animals. If so, the chief contributions which the microbiologist has to offer to the human physiologist and pathologist is the insight that—apart from hydrolysis and its reversion —the whole of cell metabolism can be reduced to chains of coupled dehydrogenation and hydrogenation reactions and that in one cell there is only one specific catalytic agent which promotes all these reactions.

It is obvious that this view is not without bearing upon the cancer problem as well. For it would mean that the conversion of a normal tissue cell into a cancer cell could ultimately depend on a quantitative change in property of one single catalytic agent which determines metabolism.

The question arises: What do we know about this catalytic agent and more especially about the property which directs metabolism?

The answer can only be that the agent itself is practically inaccessible to direct investigation, since it can not be isolated out of the cell complex without seriously damaging its activity. However, it seems probable that we can learn something about the property in question by studying its influence on oxido-reduction systems present in the medium of the cells. This way seems the more promising, since we have in the determination of oxidation-reduction potential of the medium a convenient method for the measurement of the intensity of this influence.

In the course of time already numerous publications have appeared on the changes in oxidation-reduction potential in culture media as effected by the growth of micro-organisms. However, the greater part of these investigations is of an empirical character in so far as media of unknown composition have been used, and only exceptionally an attempt is made to trace the relations between metabolism and redox potential.

Still there is ample evidence of a more general nature that such a relation exists. Already the classical researches of W. Mansfield Clark leave no doubt that there is an intimate connection between the chemical activity of living cells in a medium and the potential of this medium. Later investigations from Coulter, Hewitt, Plotz and Geloso, Fildes and Knight, Lepper and Martin have fully corroborated this view. Nevertheless, in all these investigations the authors have not tried to relate the observed potentials with the chemistry of a special metabolic process.

A beginning in this direction was only made in a few papers. So Boyland brought experimental proof that the rate of cell-free alcoholic fermentation of sugar depended on the oxidation-reduction potential of the medium. Kusnetzow found the interesting fact that the direction in which glucose was converted under the influence of *Aspergillus niger* was materially affected by the potential or the pH of the medium.

The desirability of getting a better insight into the interrelation of metabolism and oxidation-reduction potential of the medium has induced my collaborator Elema[3] to further research.

From the start it was evident to us that it was of utmost importance to simplify the conditions of the experiments as far as possible. For this reason we have looked out for a metabolic process which can proceed in the absence of free oxygen, since the variable oxygen tension in different layers of culture media has often complicated the results of the earlier investigators. Furthermore, it was desirable that the cells involved would be able to show a normal metabolism in a simple synthetic medium.

We have found these conditions fulfilled in making use of denitrifying bacteria, of which several species are able to thrive quite vigorously in a simple medium prepared from tapwater with the addition of ethyl alcohol, potassium nitrate and some phosphate.

As a first result may be mentioned that also in this synthetic medium reproducible changes in potential occurred which were highly independent of the nature of the electrodes used, but which were evidently determined by the metabolic processes effected by the bacteria, since in the absence of bacteria no specific potential could be observed. This may be deemed remarkable, since in this case the cooperation of other oxidoreduction systems than those which originate from the bacteria in the establishment of the measured potential difference is excluded.

In studying the changes in potential during the course of the development of denitrifying bacteria, we were soon struck by the fact that after an initial period, in which evidently the electrode was not yet

[3] *Cf.* B. Elema, "De bepaling van de oxydatie-reductie potentiaal in bacterien cultures en hare beteekenis voor de stofwisseling," Delft, 1932.

adjusted, the changes were dominated by simultaneously occurring changes in pH, to the understanding that there was an unmistakable parallelism between the curve of the redox potential and that of pH. However, finally always a sharp drop in potential occurred which was not accompanied by a corresponding drop in pH.

Our attention was drawn to the remarkable circumstance that this final drop in potential coincided with the disappearance from the medium of an intermediately occurring metabolic product—the nitrite.

So here—as far as is known for the first time—a direct relation between the oxidation-reduction potential and a definite metabolic product was traced.

This view was fully confirmed by further investigations in which the denitrification of nitrite itself was studied. In these experiments the necessity of growth of the bacteria was excluded by raising the number of the cells in the suspensions. Under these conditions it could be ascertained that at any moment—as long as nitrite was still present—the potential observed was directly dependent on the pH, at least as long as a value of 9.1 had not yet been attained. With a further increase in pH the potential remained constant at a definite level until the nitrite again had been consumed.

These results were completed by the observation that in a medium from which the nitrite had disappeared, the original value of the potential was immediately restored by the addition of the smallest trace of nitrite. However, the concentration of the nitrite proved to be without any influence on the potential.

If we try to interpret these findings we must conclude that from the several reversible oxidoreductions which proceed in rapid succession at the surface of the catalyst, the reaction with the slowest rate, *i.e.*, the reduction of the nitrite, is determining the oxidation-reduction potential in the medium. But since the concentration of the nitrite in the medium is of no importance we may infer that only the small part of the nitrite that is adsorbed at the catalyst participates in the oxidoreduction system that primarily is responsible for the potential measured.

This is a further proof that this potential is a characteristic result of the interaction between metabolic substrate and the heterogenous catalyst.

With this insight gained it seemed of importance to investigate in how far the measured potential could be influenced by adding to the medium typical reversible oxidoreduction dyes like methylene blue, etc. *A priori* it seemed quite possible that addition of minute quantities of these dyes would have no other influence than an acceleration of the adjustment of the electrode to the surrounding medium.

In this line of thought several investigators have added very small quantities of oxidoreduction indicators, tacitly assuming that this addition would not alter the oxidoreduction state of the medium under investigation. Whilst this is true in those cases wherein true equilibria of sufficient capacity are studied, our experiments have shown that this does not hold good in the case of stationary reaction as occur under the conditions chosen by us.

On the contrary, the experiments made left no doubt that even traces of oxidoreduction indicators markedly influence the redox potential of the medium. We are inclined to attach rather great importance to this result with a view to the intimate connection which evidently exists between metabolism and redox potential in the medium. If we are entitled to refer this potential under normal conditions to the metabolic processes of the cells which are present in the medium, then we must conclude that changes in this potential mean a change in metabolism of these cells. We might look upon it in this manner that the stationary reaction state is modified by the interference of the added indicator, as a hydrogen donator in its reduced form as a hydrogen acceptor in its oxidized form. This will imply that the normal metabolic oxidoreductions will be changed at least in a quantitative sense, but it is also quite conceivable that the change in potential which results from the addition of the oxidoreduction system will prevent the occurrence of special oxidoreduction reactions of the cells or promote others.

If, in concluding, I may venture to dwell for a moment on the possible significance of these observations for the cancer problem, I should like to make the following remarks.

The cornerstone of our knowledge of the metabolism of cancer cells is nowadays still—in spite of some incident adverse criticism—the fundamental discovery made by Otto Warburg of the prevalence of glycolytic activity also under aerobic conditions.

Although nothing can be said with certainty, this makes it probable that metabolism in a cancer cell will induce a more reduced level, *i.e.*, a lower reduction potential than the normal cell will have, owing to its metabolism in which free oxygen takes a preponderant place.[4]

This hypothesis is materially supported by the important findings of Albert Fischer, of Copenhagen, on the increased proteolytic activities of pure cultures of cancer cells as compared with normal ones.

[4] This opinion does not necessarily conflict with the recent observations of Waterman, who reports that serum of cancer tissue had a higher potential than that of normal tissue, since these measurements relate to media in which the living metabolizing cells were absent. *Cf.* Acta Brevia Neerlandica 1, p. 188, 1931.

For the investigations of Grassmann and of Waldschmidt-Leitz have shown beyond doubt that proteolysis is a process which is strongly intensified by natural activators like glutathione, but only in so far as they occur in the reduced state. The strict correlation of reduced state and proteolysis is moreover clearly demonstrated by the general occurrence of low potentials in cell suspensions as soon as active metabolism ceases and autolysis sets in.

In this connection it is tempting to see a cancer cell as a cell in which autolytic processes have overcome the opposing forces of metabolism, but which on their way to complete autolysis have found a new stationary state at the moment of the passing of the potential which corresponds to glycolysis.

At first sight one might therefore expect that it should be possible to restore the respiratory function of the cancer cell by adding to the medium a reversible oxidoreduction system by which the potential of the environment and therewith the potential at the catalyst would be raised. The mentioned effect of the addition of oxidoreduction system on suspensions of denitrifying bacteria proves the appropriateness of such a procedure.

Moreover, the discovery of Barron and Harrap of the methylene blue respiration of erythrocytes gives direct proof that it is possible to change by this means a glycolytic metabolism into a respiratory one.

However, there is sufficient evidence in the work of Warburg, Kisch and others that the same step with cancer cells is ineffective.

It seems to me that this negative result is of far-reaching significance. For we must conclude that the change in metabolism which a normal cell undergoes by its transformation into a cancer cell does not have its primary cause in the lowering of the potential at the catalyst with the reduction of respiration as a consequence. On the contrary, all points to the probability that inversely the downfall of the potential is caused by the decline of the respiratory function.

This must be deemed quite possible on the basis of the duality of the given theory of respiration. In contrast to fermentation, respiration asks for a special oxygen activating apparatus besides the biocatalyst which primarily is responsible for the oxidation-reduction potential in the cell and its environment. A defect in this oxygen activating apparatus—Warburg's "Atmungsferment"—will suffice to diminish or prevent normal respiratory activities. The result will be a lowering of the potential which ultimately will lead to autolysis and death, but which, under special conditions, may find a new stationary reaction state at the basis of a glycolytic metabolism. In this line of thought there does not seem to be much hope for the restoration of a cancer cell into a normal one.

It may be remarked, by the way, that this representation admirably fits in with the hypothesis formulated quite recently by Crawley in his recent paper,[5] according to which the essential difference of malignant cells from the normal ones is to be found in the fact that the protein sols of the former are in a chronic state of excessive peptization, *i.e.*, the micelles are smaller than those occurring in normal cells.

Still it would be premature to conclude from the foregoing that cell metabolism in its present state of development has nothing to offer to cancer research. For, although attempts to bring the cancer cell back to its normal state may not seem promising, still it might *be possible to prevent its proliferation.*

Indeed, there seem to be several indications that we have in the maintenance of relatively high potentials a decisive means of preventing those hydrogenations which are essential for the formation of new cell substances, *i.e.*, for growth of the cells.

The first time that my attention was drawn to this point was on occasion of some observations made by Visser 't Hooft in connection with the metabolism of acetic acid bacteria. Visser 't Hooft found that, by increasing the rate of aeration of media inoculated with an acetic acid bacterium, rather soon a situation was reached in which the growth of these bacteria was altogether stopped. Nevertheless, a preformed population of these bacteria were perfectly capable of oxidizing different respiration substrates by aeration intensities which surpassed markedly the critical value for growth.

But also the denitrifying bacteria show a quite similar behavior. From the graphs in Ellma's dissertation, it may be derived that by inoculating denitrifying bacteria in an alcohol-nitrate medium in the phase of active growth, potentials are attained which are far lower than those which result afterwards from the intermediary production of nitrite. There are good reasons to conclude that as soon as the higher "nitrite potential" is established growth has altogether stopped. This would explain the rather well-known but hitherto poorly understood phenomenon that in an alcohol-nitrite medium inoculations with denitrifying bacteria are unsuccessful, notwithstanding—as we have seen before—denitrification proceeds vigorously if a preformed mass of these bacteria are added to the same medium. Obviously, the potential maintained by the presence of nitrite is too high to allow of assimilatory dehydrogenations.

It may be deemed probable that the same will hold good for the cancer cell and that *its proliferation* will be checked by maintaining in its medium a potential which will be too high for the dehydrogenation reactions which are essential for growth. Moreover, it

[5] *Jour. of Phys. Chem.*, 36: 1282, 1932.

does not seem excluded that by adding suitable oxido-reduction systems the critical growth potential can be surpassed to such a slight extent only that the critical growth potential of normal cells is not attained.

It will be clear that thoughts like these do not pretend to be more than mere suggestions for future investigation. But of one thing I feel quite sure, i.e., that the solution of the cancer problem will be the result of a deeper insight into the phenomena of cell metabolism, an insight that will be gained only by further investigation of pure cultures either of cancer cells themselves or of unicellular organisms.

HOW THE PRIMITIVE ANTS OF AUSTRALIA START THEIR COLONIES[1]

By Professor W. M. WHEELER

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THE great naturalist and physicist, Réaumur, was the first to attempt an investigation of the founding of colonies among ants, in 1743. Since that time the problem has become more complicated and we now know that these insects practice at least four different methods of colony-founding. Three of these have been satisfactorily elucidated within the past thirty years. A year ago I was able to detect a fourth, quite unexpected method in several Australian species of the very archaic and primitive subfamily Ponerinæ. All four methods represent so many peculiarities in the behavior pattern of the young, recently fecundated female or queen, and these in turn depend on the amount of her food-reserves in the form of adipose tissue and wing-musculature. Species in which these reserves are deficient are compelled to adopt one of two *dependent* methods of colony formation: the young fecundated queen either leaves the maternal colony accompanied by a band of workers that assist her in establishing a new nest and community or she becomes parasitic in a colony of an alien species. The former method is a kind of swarming analogous to that of the honey-bee, but differs in being practiced by the young queens instead of by the old mother queen of the colony. The parasitic ants are of unusual interest, but I shall consider only the two remaining methods, which are of the *independent* type.

Nearly all our ants belong to the four most recent and most specialized taxonomic subfamilies (Myrmicinæ, Pseudomyrminæ, Dolichoderinæ and Formicinæ) and found their colonies in the following manner: After fecundation by the male during her marriage flight, the large-bodied queen, which has been plentifully supplied with abdominal fat during her larval life, descends to the earth, discards her wings and immures herself completely in a small cell in the soil, under a stone or under the bark of a log. The voluminous wing musculature in her thorax, now useless for purposes of flight, at once begins to break down and dissolve in the blood, so that its proteins, together with the fat in the abdomen, can be used as food by her developing ovaries. These food-reserves enable her not only to mature a number of eggs but also to rear some of the resulting larvæ as a small initial brood of diminutive workers. During this period, which may extend to eight months or even more than a year, she manages to live exclusively on her own tissue-reserves and to feed her larvae with saliva. She also normally devours many of her own eggs and larvae or feeds them to their sister larvae. She often concentrates her care on one or a few of her offspring, so that these pupate and emerge as minute workers before the others. As soon as they are thoroughly mature they break out of the cell and secure food for themselves, their famished mother and the still undeveloped portion of the first brood. They now take over the control of the colony, provide all the food for the diminutive community and thus enable the queen to specialize henceforth as a mere egg-laying machine that supplies them with successive broods to rear. They begin to expand the nest by excavating additional cells and galleries and the colony grows apace, till its trophic status is so favorable that after a few years it can produce males and young queens. This method of colony formation I have called the *perfectly claustral method.*

I find that the Ponerinae present a very significant variant of this form of colony-founding behavior. More than thirty years ago I showed that these ants do not feed their larvae with liquids by regurgitation, but in a much more primitive fashion, with pieces of freshly killed insects. In all the intervening years I have sought their method of colony-founding, but in vain, and other myrmecologists have had no better success. While accompanying the Harvard expedition to Australia, which has the most superb Ponerine fauna of any continent, I succeeded in filling this gap in our knowledge. The richness of the Australian Ponerine fauna is shown by the fact that at least 300, or 25 per cent., of the 1,200 species, subspecies and varieties of ants now known from the island con-

[1] Read at the meeting of the National Academy of Sciences, University of Michigan, on November 15, 1932.

tinent belong to this subfamily. From the United States, which has about the same area as Australia, some 500 species, subspecies and varieties of Formicidae have been described, but only 24 species, or less than 5 per cent., are Ponerinae. In the Palearctic Region the percentage of these ants is certainly no greater, and even in the Neotropical and Paleotropical Regions they probably comprise less than 10 per cent. of the entire ant-fauna.

About a third of the Australian Ponerinae, or 100 species, belong to the genus Myrmecia, which occurs on no other continent. These are the famous "bulldog ants," some of them more than an inch in length, singularly alert, wasp-like, large-eyed, long-jawed and fiercely stinging creatures, which, apart from the poisonous snakes, are really the only formidable animals in the Australian bush. They are evidently a very ancient, Mesozoic group, which bear about the same relation to other ants that the Marsupials bear to the Placental Mammals. A closely allied fossil genus, Prionomyrmex, is known from the Baltic amber, which is of Lower Oligocene age. The larvae of Myrmecia are very primitive and are fed with pieces of freshly killed insects, though the adults seem to feed exclusively on nectar and sap. Many of the species are beautifully colored. *M. tarsata* F. Smith, *e.g.*, which is nearly an inch long, is beautiful cyan blue, with an orange-tipped abdomen. Some of the species when disturbed hop about like small grasshoppers. There are great differences in the structure of the mandibles, but the subgenera based on these appendages seem to be invalid. They are quite simple in one species, *Promyrmecia aberrans* Forel, which I found in New South Wales in 1914. It is the most primitive and archaic of all known ants and might, therefore, be compared with Ornithorhynchus among mammals. Its colonies consist of not more than a dozen individuals. Its nest, a small hole in dry soil, leads into a perpendicular gallery, about 14 inches long, terminating in a small chamber. The larger species of Myrmecia, however, build mound nests which may be from 1 to 5 feet in diameter, but their population is small and rarely exceeds 150 to 200 individuals.

Now the queens of the Ponerinae, unlike those of the higher ants, are but slightly larger than the workers, and their thorax and abdomen contain only a small amount of musculature and fat. They might be expected, therefore, to found their colonies by swarming, as I thought probable in 1900. This is not the case, however, as I have found in several species of Myrmecia, and in certain species of Amblyopone and Lobopelta in the magnificent Eucalyptus forests of the extreme southwestern corner of Australia. All these ants adopt the same method of colony formation, of which *Myrmecia regularis* may serve as a paradigm. The queen, after fecundation and deälation in the early months of the year, excavates a large flat cell under a stone and near its periphery, and closes herself off completely from the outside world. She also excavates from the floor of the chamber a gallery extending for some distance into the soil and terminating in a small pocket. This is a retreat, to which she can resort for warmth or for concealment at the slightest disturbance. She does not, however, like the queens of the higher ants, remain rigidly confined to this nest, but, from time to time, breaks through the peripheral wall and forages for food in the open. In November and December (the Australian summer) she starts her brood by laying a number of eggs, which are nearly spherical and are scattered on the floor of the flat upper chamber and not kept in a packet, like the eggs of the higher ants, because she seems to have no salivary secretion with which to glue them together. As soon as the young larvae hatch she leaves the chamber from time to time to capture insects with which to feed them. Both after leaving and after returning to the nest she carefully closes the passageway which she has made in the peripheral wall. Except for her occasional foraging excursions to obtain food for herself or her progeny, the queen's subsequent behavior in rearing the brood is like that of the higher ants.

The independent colony-founding procedure of the Ponerinae may therefore be designated as an *imperfectly,* or *intermittently claustral method.* It is of considerable interest for three reasons: first, being essentially like the method employed by the social wasps (*e.g.,* by our hornets and yellow-jackets of the genus Vespa), it confirms our conviction, reached from many morphological and taxonomic considerations, that the ants are merely a peculiar group of social Vespoids. Second, this intermittent method of colony-founding suggests that the perfectly claustral method of the higher ants is a late, derivative and highly specialized form of behavior due to the queen's endowment with a considerable accumulation of tissue-reserves and her ability to feed her brood with salivary secretions. And third, the fact that the intermittent is the prevailing and perhaps the only method of colony-founding among the Ponerinae, which are unanimously regarded as the ancestors of the other seven taxonomic subdivisions of ants, supports the theory that the haplometrotic, or single-mother-family, rather than the pleometrotic, or multiple-mother-family, is the phylogenetic basis of all the diverse societies encountered among the hymenopterous insects.[2]

[2] For a detailed account of the Ponerine method of colony-founding see my forthcoming book, "Colony-Founding among Ants," Harvard University Press, 1933.

SCIENTIFIC EVENTS

INTERNATIONAL COOPERATION OF SCIENCE MUSEUMS

IT is reported in *Museum News* that the International Institute of Intellectual Cooperation of the League of Nations has issued a report of the conference held at Geneva this summer on collaboration between science museums. Andrey Avinoff, director of the Carnegie Museum, was president of the conference and represented the American Association of Museums. After four sessions on July 14 and 15, the conference adopted resolutions recommending the following:

The establishment at the International Institute of Intellectual Cooperation of an information and documentation center to deal with matters concerning science museums.

The collection of information of certain kinds: catalogues of films and negatives; technical information on museum building construction, ventilation, lighting, heating and preservation of specimens; types of labels and explanatory diagrams; a list of model exhibits in museums; catalogues of duplicates available for exchange and of material for study by specialists; lists of models and casts that might be made in quantity for cession or loan to other museums; publications; a list of specialists in the different branches of science.

Promotion of exchange of curators or travel by curators, with a loan fund for this purpose. Development of concerted organization of scientific expeditions.

Extension of the collaboration among museums for loans, exchanges, traveling exhibits, etc.

Investigation of educational methods used by museums, and publication of the results.

Publication of a directory of science museums and of a periodical bulletin.

The committee consisted of Andrey Avinoff; Sir John Flett, director of the Geological Survey and Museum, London; Paul Lemoine, director of the Musée National d'Histoire Naturelle, Paris, and Wilhelm Unverzagt, director of the Staatlichen Museums für Vor-und-Frühgeschichte, Berlin. The meetings were attended by M. Bonnet, director of the International Institute of Intellectual Cooperation, and his colleagues Messrs. Establier and Belime.

THE NORTH INDIA EXPEDITION OF YALE UNIVERSITY

THE Yale North India Expedition, now in Srinagar, Kashmir, has mapped in detail an area of more than 4,600 square miles of hitherto unexplored country lying in the Himalayan Range above an altitude of 14,500 feet, according to the report of its director, Professor Hellmut de Terra. Fossils were found of both lower and higher forms of animal life which will throw new light on the geological history of Central Asia and the development of the fauna of North India while the mountains in this region were being formed. The expedition left the United States for India early in the spring. Due to the cooperation of the governments of India and Kashmir, no serious losses or obstacles have been encountered.

The new map of the previously unknown area in the Himalayas will be of value in understanding the geography of this region. The expedition was aided in making the map by Khan Sahib Afraz Gul, one of India's best mountain topographers, who joined the survey through the courtesy of the Surveyor General of India, and the generosity of the American Geographical Society.

Professor G. E. Hutchinson, biologist, and Mr. G. E. Lewis, paleontologist, made a detailed study of both present and past animal and plant life. The elevated lakes were examined both chemically and biologically, and will be compared to the existing conditions of western Central Asia. Information gathered concerning the environment of the terrestrial invertebrates will throw light on factors determining the distribution of animal life in high regions, and on trends of development as compared to that of animal life in the adjoining lowlands.

The report states that the contrast of the fauna to that of the rest of India is most striking. A paleontological collection from Ladakh, made by Mr. Lewis, will arrive at the Peabody Museum of Yale University later in the season. Mr. Lewis succeeded in obtaining in the Siwalik Hills of Northern India a collection of vertebrate specimens dating from the tertiary period. They are in a very good state of preservation.

Professor de Terra writes: "During this time the members of the expedition traveled 1,300 miles across the barren mountain ranges north of the Himalaya which are known as the Eastern Karakorum. This meant moving a large scientific apparatus as well as provisions on ponies and yaks across passes over 18,500 feet, often still covered with snow. As the greatest portion of the area traversed lies beyond the upper limit of human habitation, the highest permanent settlement being situated at 14,500 feet above sea level, food depots had to be established at various stages along the route." Geological data obtained tend, it is said, to prove that Himalaya and Karakorum, the world's highest mountain ranges, possess a geological structure similar to that which characterizes the Alps in Europe.

During the last months of the expedition the members will follow separate fields of research. Dr. de

Terra will continue his geological work in Kashmir where the most recent mountain building has been going on. Dr. Hutchinson is leaving immediately for southern India in order to study the occurrence of relics of a Himalayan fauna. Mr. Lewis will resume his paleontological excavations in the Salt Range of the Punjab. The work of the expedition will be completed by February and will arrive in the United States in the early spring of 1933.

THE U. S. GEOLOGICAL SURVEY

THE annual report of the director of the U. S. Geological Survey states that the geologic work of the year included studies of many mining districts in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, and Oregon; of lead and zinc deposits in Virginia; of iron ores in Alabama and the Lake Superior region; of coal fields in Montana, New Mexico, Oklahoma, and Utah; and of oil fields and prospective oil and gas areas in California, Colorado, Mississippi, and Utah; besides general mapping and studies in many parts of the country.

Research work on fundamental problems of geology included special attention to the source rocks of petroleum, the structure and constitution of coal, and the systematic study of diatoms.

Investigation of mineral-bearing areas that might contribute tonnage to the Alaska Railroad was undertaken under a special appropriation of $250,000 made by Congress after the visit of a senatorial committee to Alaska in 1930. Continuation of the regular survey work in Alaska resulted in the geologic mapping of nearly 6,000 square miles and the topographic mapping of 5,680 square miles.

The topographic maps originally prepared as an essential base for detailed geologic mapping have proved to have many other uses, and the general realization of their value is shown in the increasing funds made available by states and other federal units for cooperation in this work. The topographic mapping done during the year covered nearly 26,000 square miles. Ten states, the District of Columbia, and Hawaii are now completely mapped, and the percentages in the other states range from eight in Florida to 88.9 in Virginia. Of the continental United States, exclusive of Alaska, 45.2 per cent. has been mapped. Office mapping from aerial photographs by stereophotogrammetric methods was completed for the Zion National Park and nearly completed for the Bryce Canyon National Park, both in Utah.

The study of water resources included stream gaging at about 2,800 gaging stations in all the states, the District of Columbia and Hawaii and investigations of ground water and power or reservoir sites in twenty-five states and Hawaii.

The classification of public lands with respect to their mineral, waterpower and agricultural value resulted in net decreases of 932,166 acres in areas withdrawn as possible coal or phosphate land and of 54,100 acres in areas classified as oil-shale land and a net increase of 510,217 acres in areas classified as coal or phosphate land.

The appropriations made directly to the Geological Survey for the year amounted to $3,141,740. Most of the states and several other government units cooperated in one or more phases of the work, the total amount available from all sources being $5,115,087. The unexpended balance of federal money at the end of the year was $206,412, of which $150,000 was made available by the Seventy-second Congress for expenditure in the fiscal year 1933.

THE REVIEW OF SCIENTIFIC INSTRUMENTS

ON January 1, 1933, The Optical Society of America will transfer to the American Institute of Physics the duty of publishing *The Review of Scientific Instruments*. At the same time, the Institute plans to expand the journal and to coordinate it with the entire list of Institute publications.

Under the new plan, *The Review* will contain each month an added section of "Physics News and Views." In this section it is planned to give a non-technical discussion of important developments in physics. Other features will be editorials, personal and institutional notes, programs and news of society meetings, book reviews and a summary of the contents of contemporaneous journals of physics.

The new section will in no way displace the present contents. Scientific articles on instruments and methods will continue to constitute the major portion of *The Review*. The abstracts of instrument literature will be retained. These original features of *The Review* will continue to be edited by Professor F. K. Richtmyer and a board appointed by The Optical Society of America.

The enlarged *Review* will be sent not only to all members of The Optical Society as at present but to every member of The American Physical Society, The Acoustical Society of America, The Society of Rheology and The American Association of Physics Teachers as well. It is planned, in addition, to send it to every non-member subscriber to any one of the Institute's publications, namely, *The Physical Review, Reviews of Modern Physics, Physics, Journal of The Optical Society of America, Journal of The Acoustical Society of America, Journal of Rheology* and the new *Journal of Chemical Physics*. For the members and other subscribers, combination rates will be so adjusted that *The Review* will come to them along with the journals they now receive for the same price as

they would have paid without it. The institute is enabled to render this service through the expectation that advertising in the journal will go far toward supporting it. It is to be made the sole advertising medium of the institute's publication program, the other journals being reserved exclusively for papers and articles in their respective fields. The new *Review* represents a service which will be shared by about five thousand individuals actively interested in physics and its closely associated fields.

SCIENTIFIC NOTES AND NEWS

A MEETING in commemoration of Graham Lusk, late professor of physiology in the Cornell Medical College, will be held under the auspices of the Harvey Society at the New York Academy of Medicine on Saturday evening, December 10, at 8:30 o'clock. Addresses will be made by Dr. Anton J. Carlson, Dr. Russell H. Chittenden, Dr. John A. Hartwell, Dr. Elliott P. Joslin, Dr. William S. McCann and Dr. Homer F. Swift.

DR. J. B. S. HALDANE, Sir William Dunn reader in biochemistry at Cambridge, head of the genetical department of the John Innes Horticultural Institution and Fullerian professor of physiology at the Royal Institution, London, was the guest of honor at a dinner on December 6, given by the American Institute, New York, at the American Museum of Natural History.

THE Board of Governors of the West China University gave a luncheon on December 6 in honor of Dr. and Mrs. R. Gordon Agnew, who are about to return to China. Dr. Agnew gave a résumé of work conducted by him and Mrs. Agnew on tooth decay, which was discussed by Dr. E. V. McCollum, professor of biochemistry in the School of Hygiene and Public Health of the Johns Hopkins University.

DR. EDMUND A. CHRISTIAN, Pontiac, Michigan, has been honored by friends and associates at a dinner celebrating his seventy-fifth birthday. In recognition of his fiftieth year in the practice of medicine in the state, a bronze plaque, executed by Carleton Angell, was unveiled during the dinner. It will be hung in the administration building of the Pontiac State Hospital, where for thirty-eight years Dr. Christian has been superintendent.

A DINNER was given on October 31, in honor of his seventieth birthday and of his retirement as chief engineer of the Board of Transportation of the City of New York, for Robert Ridgway at the Engineers' Club. Congratulatory messages were read from President Hoover, Governor Roosevelt, Acting Mayor McKee, Herbert S. Crocker, president of the American Society of Civil Engineers, and others. Mr. Smith presented to Mr. Ridgway a framed testimonial with the signatures of about 200 engineers and associates in the construction of the city's subways, aqueducts, under-river tunnels and water-supply system.

DR. C. L. MARLATT, chief of the U. S. Bureau of Entomology, was entertained recently by the Southern California Entomological Club, at the University of California's Citrus Experiment Station, at Riverside. More than a hundred members of the club greeted Dr. Marlatt, and listened to the address in which he told of the work of the bureau.

AT the recent Atlantic City meeting of the Radiological Society, Dr. W. Herbert McGuffin, of Calgary, Alberta, Canada, was named *president-elect*. Other officers elected were: Dr. W. Edward Chamberlain, of Philadelphia, *first vice-president;* Dr. W. Warner Watkins, of Phoenix, Arizona, *second vice-president;* Dr. Harold A. Spillman, of Ottumwa, Iowa, *third vice-president,* and Dr. Donald S. Childs, of Syracuse, *secretary and treasurer.* During the banquet the society's annual medal for distinction in radiology was presented to Dr. Leon Jean Menville, of New Orleans, who was recently appointed editor of *Radiology,* the journal of the society.

DR. W. G. WORKMAN, of the U. S. National Institute of Health, is suffering from an attack of typhus fever, which he helped to prove is transmitted by fleas. He is the third of the institute's staff to be stricken by the disease during the investigations. Just a year ago Dr. E. T. Ceder suffered an attack of typhus fever; Dr. R. E. Dyer, director of the typhus research work, is now convalescing from the disease.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, was recently elected a corresponding member of the Northern Arizona Society of Science and Art.

DR. RUDOLPH MATAS, emeritus professor of surgery at Tulane University School of Medicine, has received through René Dalage, consul-general of France, the insignia of a knight of the Legion of Honor.

M. CABRERA, member of the Academy of Sciences at Madrid, and of the Institute of Physics, Chemistry and Physical Chemistry, has been made a doctor, *honoris causa,* by the University of Strasbourg.

THE University of Liverpool has conferred the title of professor emeritus on Dr. J. S. Macdonald, Holt professor of physiology from 1914 to 1932.

DR. WALTER LANGDON BROWN, Regius professor of physic, and Dr. John Edward Lennard-Jones, Plum-

mer professor of inorganic chemistry, University of Cambridge, were recently elected fellows of Corpus Christi College.

LORD MACMILLAN has agreed to succeed Lord D'Abernon as president of the National Institute of Industrial Psychology, London.

DR. ARMITAGE WHITMAN has been appointed a member of the Public Health Council of, and orthopedic surgeon to, the New York State Department of Health.

DR. ETIENNE B. RENAUD, chairman of the department of anthropology at the University of Denver, has been appointed consular agent in Colorado and the neighboring territory by the French Government. Dr. Renaud is a native of France. He became an American citizen in 1913 and served as an American infantry officer during the war. He will continue his work as an archeologist and as professor at the University of Denver.

M. PALOQUE, associate astronomer of the Observatory of the University of Toulouse, has been appointed director to succeed the late M. Casserat.

M. BOUIN, of the University of Nancy, has been appointed to a newly established professorship of applied zoology.

THE Committee on Scientific Research of the American Medical Association has awarded a grant to Dr. A. P. Locke, of St. Luke's Hospital, Chicago, for the further study of the copper and "active" iron in tissues in infection and toxemia.

DURING the absence of Sir Arthur Keith on account of illness his work as conservator of the Museum of the Royal College of Surgeons will be undertaken by R. H. Burne, physiological curator.

ABBÉ GEORGES LE MAITRE, of Belgium, will visit California to carry on work at the Mount Wilson Observatory.

DR. G. MONTALENTI, of the University of Rome, is studying this year in the department of zoology of the University of Chicago. He spent the summer at Woods Hole, working at the Marine Biological Laboratory.

SIR JAMES C. IRVINE, principal of the University of St. Andrews, Scotland, an authority on the chemistry of the sugars, lectured at Yale University on November 14, on "New Developments in the Chemistry of Starch and Cellulose."

DR. HEBER D. CURTIS, director of the observatory of the University of Michigan, gave a public lecture at the Carnegie Institute of Technology, Pittsburgh, on December 8, on "Recent Eclipse of the Sun." On December 12 and 13, Dr. Paul E. Sabine, of the Riverbank Laboratories, Geneva, Illinois, will speak on "Recent Developments in Applied Acoustics."

PROFESSOR S. O. MAST, of the department of zoology of the Johns Hopkins University, addressed the Alpha Mu chapter of Tri Beta at Western Maryland College on November 22. The subject of the address was "Color in Organisms."

DR. JOHN E. WOLFF, professor emeritus of petrography and mineralogy at Harvard University, spoke at a recent meeting of the Mineralogical Society of Southern California in Pasadena. He discussed the optical character of minerals as seen in the polarizing microscope.

DR. ALBERT KUNTZ, professor of micro-anatomy in St. Louis University School of Medicine, gave a lecture on November 19 before the Mendel Club of Spring Hill College, on "The Cerebral Cortex in Relation to Psychic and Mental Processes." On the same day he spoke to the Mobile County Medical Society on "Visceral Sensitivity and Referred Pain."

DR. ELMER EDGAR HALL, professor of physics and chairman of the department at the University of California, died on November 19, at the age of sixty-two years. Dr. Hall had served on the staff of the department of physics for over thirty years, and had been chairman of the department since 1925.

PROFESSOR R. L. GREEN, professor emeritus of mathematics and from 1925–1927 the executive head of the department of mathematics at Stanford University, died on November 19 in his seventy-first year.

AN international congress of ophthalmology will be held in Madrid in April, 1933. Abstracts of articles to be read at the congress should be sent to the secretary, Dr. F. Poyales, Olazaga 3, Madrid.

THE eighteenth annual meeting of the American Association of Petroleum Geologists will be held from March 23 to 25, at Houston, Texas. At the same time meetings will be held of the Society of Economic Paleontologists and the Society of Petroleum Geophysicists.

THE American Society of Agronomy held its twenty-fifth anniversary meeting in Washington, D. C., on November 17 and 18, at the Willard Hotel. The general program included a historical report on the growth of the society by the historian, Dr. T. L. Lyon, and papers tracing the development of soil science and crop science during the past twenty-five years by Dr. J. G. Lipman and Dr. C. W. Warburton, respectively. Several symposia programs were arranged and a number of general programs on which papers on general crops and soils interest were presented. The address of the retiring president, Dr. P.

E. Brown, was given at the annual dinner and was entitled "The Mystery of the Soil." The new officers of the society elected for the ensuing year are Dr. M. A. McCall, U. S. Bureau of Plant Industry, Washington, D. C., *president;* Professor R. I. Throckmorton, Kansas State College, Manhattan, *vice-president;* Dr. M. T. Jenkins, Iowa Agricultural Experiment Station, Ames, *chairman* of the Crops Section; Dr. Richard Bradfield, the Ohio State University, Columbus, *chairman* of the Soils Section; Professor J. D. Luckett, New York Agricultural Experiment Station, Geneva, *editor;* Dr. P. E. Brown, Iowa State College, Ames, *secretary-treasurer.*

Nature states that a brilliant company assembled in the hall of Pembroke College, Cambridge, on November 12, to celebrate by a dinner the centenary of the grant of a Royal Charter to the Cambridge Philosophical Society. Dr. A. Hutchinson, the master of the college and president of the society, was in the chair, and the occasion was honored by the presence of H.R.H. Prince George. Among other distinguished people present were Mr. Stanley Baldwin, chancellor of the university, the presidents of the Royal Society and of the British Association, and presidents or directors of many other leading scientific societies and institutions. The toast of the society was proposed by Prince George and replied to by Dr. Hutchinson. The Master of Trinity proposed the toast of the guests, and responses were made by Mr. Baldwin and Sir William Bragg. In his reply to the toast of the society, Dr. Hutchinson gave an account of its origin and early work. In the course of his speech he said that he had been empowered by the council of the society to propose that the office of patron be revived, and that the present Chancellor, Mr. Baldwin, be invited to accept it.

FOLLOWING the success of a similar series last year, a second series of lectures interpreting the relationship of science to mankind will be given during the winter quarter at the University of Minnesota, under the auspices of Sigma Xi. The title of this year's series is to be "Science and Human Welfare." The lectures, which will be open to the public, will be free; the attendance reached 5,000 last year. This will be the fifth year in which Sigma Xi has presented a lecture series dealing with the importance of science to man, and with the important relationships between the two. The series will be started by Dr. Elvin C. Stakman, professor of plant pathology at University Farm, who will speak on "Problems of Human Subsistence," February 22. Dr. Charles A. Mann, head of the department of chemical engineering, will speak March 1 on, "Chemistry in the Service of Man." On March 8, Dr. Dwight E. Minnich, head of the department of zoology, will speak, taking as his topic, "Biology and Social Progress." Dr. Guy Stanton Ford, dean of the Graduate School, is to be the final speaker. "Science and Civilization" will be the subject of his lecture. Professor Donald G. Paterson, of the department of psychology, is president of Sigma Xi this year and in that capacity is chairman of the committee that has arranged the series of lectures. Other officers are: *Vice-president,* Dr. George O. Burr, botany; *Secretary,* Professor Frederick B. Hutt, animal genetics; *Treasurer,* Professor Alice Biester, home economics.

Museum News reports that the survey of the museums of the British Empire financed by the Carnegie Corporation of New York and undertaken by the Museums Association (British) has been about two thirds completed. Territory already covered includes Canada, South Africa and the British possessions in the Mediterranean (Malta, Cyprus and Gibraltar). The report on the Canadian survey, with accompanying directory, has already been submitted to the Carnegie Corporation. To complete the survey there remains Australia, Tasmania, New Zealand, the West Indies and outlying possessions. The Canadian and South African surveys were made by Sir Henry A. Miers and S. F. Markham; the Mediterranean, by Charles Squire and D. W. Herdman. The Museums Association plans to publish a directory of museums in the dominions. This, with the recent directory of museums in the British Isles, will form a directory of the Museums of the British Empire.

RAPIDAN CAMP, the President's mountain retreat in the Blue Ridge Mountains within the park area, has been selected by the Virginia conservation and development commission as a part of the proposed Shenandoah National Park. It will be turned over to Congress with other land along the crest of the Blue Ridge Mountains to be proclaimed the Shenandoah National Park. The National Park Service probably will reserve the camp for use of future presidents.

A TRACT of some 1,400 acres of forest of the spruce-hemlock type of the Pacific Northwest has been set aside by the Forest Service, to be kept in perpetuity in its natural state for educational and scientific purposes. It will be known as the Quinault Natural Area. It lies within the Olympic National Forest in the State of Washington. Some of the best Sitka spruce timber obtained by the Federal Government for airplane construction in the war was cut from adjoining lands. The setting aside of this area is part of a nation-wide program of the Forest Service to preserve for posterity typical bodies of important

timber types for observation and study. The virgin stands of some of the other distinctive forest types have already been cut away and have thus become lost to plant science and future generations.

IN the article entitled "A Concept of the Ultramicroscopic Virus Diseases and a Classification" by Professor Earl B. McKinley, printed in the issue of SCIENCE for November 18, the words "the filtrability of" were omitted from the heading near the top of page 453. It should read: "IV. Virus Diseases with no Cell Inclusions Which are Transmissible and the Filtrability of the Causative Agent has been Definitely Established."

DISCUSSION

EXPLORATIONS IN CHINA

THE Commission for the Preservation of Antiquities read with great surprise the recently published statement, evidently given out by Dr. Roy Chapman Andrews, in which he seemed purposely to mix up a matter of purely scientific interest with the present political situation. In 1928, the commission did voice Chinese public opinion in objecting to Dr. Andrews' expedition, which freely made extensive excavations of paleontological and archeological objects from Chinese territory under the cover of a simple hunting passport. But the commission never ceased to assure the American Museum of Natural History of its friendly attitude toward scientific cooperation, and, in fact, the commission itself in March, 1930, entered into an agreement with Dr. Andrews for a Sino-American cooperative expedition into Inner Mongolia, which was carried to a successful completion. The agreement, while giving full consideration to the scientific interest of the expedition, tried to provide for necessary safeguards of Chinese interest and participation in this important scientific enterprise. But in view of the interest of the American Museum of Natural History in having representative specimens kept in New York, the agreement was so worded as to make possible the transport of the bulk of the collection to America for scientific study, requiring the return to China only of representative duplicates of the fossils and two casts of those specimens without duplicates, so that there will be in China a complete representation of the whole fauna collected. With this agreement approved by the Chinese Government, the bulk of the collections was allowed to be exported to America for scientific study.

It was, however, voluntarily and repeatedly declared by Dr. Andrews, in 1930, that that expedition was to be the last one of a series which he had carried out since 1922. The commission was thus surprised to receive in the spring of 1931 a letter from Dr. Andrews asking for permission for another expedition without any interview with any representative of the commission. Dr. Andrews shortly returned to America and repeatedly attacked the Chinese Government with unfriendly articles in the American press. Not a word has been received by the commission from Dr. Andrews this time, and the commission has had no knowledge whatsoever of his recent coming to Peiping until his last published statement. Thus the friendly cooperation between the American Museum of Natural History with Chinese scientific institutions has been made difficult, solely because of the unfriendly attitude of its representative, Dr. Andrews himself. The commission anticipates that the American Museum will itself deplore, as does the commission, the recent statement of Dr. Andrews, which is so contrary to the position of justice and friendship taken by the American Government and public in the present unfortunate situation. We are confident that the great American institution does not really intend to use any political weapon to intimidate the Chinese Government, in order to obtain an authorization for scientific cooperation, which this commission is always ready to promote, whenever proposed, on a fair and reasonable basis. With such understanding, the commission again declares itself ready to consider or submit to the proper higher authority or refer to the proper Chinese scientific institution any proposal of Sino-American cooperation for scientific expeditions despite any possible existing personal misunderstanding, and expresses its regret that Dr. Andrews sees fit to make such a declaration, which would make the real attitude of the American Museum misunderstood by the Chinese people.

CHANG CHI, *Chairman*
National Committee for the
Preservation of Antiquities

THE above statement was sent to the president of the American Museum of Natural History on September 24 with the following letter signed by Mr. Chang Chi:

I have the honor to enclose copy of a statement recently issued by this Commission regarding the interruption of the Central Asiatic Expedition which I regard as a most unfortunate breach in the cultural relations between China and the United States. The position of this Commission is clearly defined in that statement. Although I have not had any personal part in the negotiations, I have always fol-

lowed the reports with interest, and regret most deeply that they should have been brought to a close largely by what appears to me to be personal reasons.

That this view is shared by most foreigners in China is clear from the editorial appearing in the American owned and edited *China Weekly Review* of September 10, copy of which is herewith enclosed. While I do not wish it to be thought that we endorse all the opinions expressed in that editorial, and I want particularly to dissociate myself from certain irrelevant statements about Dr. Andrews, it nevertheless serves to call attention to certain difficulties which confronted my associates but which they have not deemed necessary to place too much emphasis before.

I repeat from our statement that this Commission is always ready to promote scientific cooperation, if proposed on a fair and reasonable basis; but that it cannot accept responsibility for failures due to unfriendly attitude exhibited by other parties.

To this letter Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, replied on November 14 as follows:

I have your letter of September 24th, regarding the closing of the Central Asiatic Expedition work in China. I agree with you that it is a most unfortunate breach in the cultural relations between your country and the United States.

The American Museum of Natural History entered upon its investigations in 1921 with a full understanding with the Geological Survey of China. It was agreed that we would confine our explorations to regions where the Geological Survey could not work. These districts were clearly specified by Dr. V. K. Ting, then director of the survey. In return, the survey agreed that we could work unhampered in Mongolia. We have satisfactorily carried out our part of the bargain. The Geological Survey, at that time representing the scientific men of North China, has not adhered to its part of the agreement.

Until 1928 the expedition had the most cordial relations with Chinese scientific men. In that year, when the Central Asiatic Expedition returned from Mongolia, its collections were detained at Kalgan without any legal or moral right for six weeks by order of the unofficial body known as the "Cultural Society." The American Museum was astonished at such treatment and naturally highly disturbed. It was charged by the Cultural Society that the expedition went into the field with only "hunting permits." That year the expedition had the same permits that it had had in all preceding years. The Cultural Society, the Geological Survey and the entire world knew exactly upon what work the expedition was engaged.

In 1929, the expedition was not allowed to proceed into the field because of demands made by your commission which we consider were exorbitant and without international precedent.

In 1931, Dr. Andrews came to Peking, at my request, to negotiate with your commission for further work in Mongolia, which had been made necessary by the discoveries of the 1930 expedition. To our great surprise, he was not even accorded the courtesy of an interview by your commission. Such treatment of the official representative of the American Museum can not be lightly passed over.

After mature deliberation, I decided in conference with the scientific staff that it was useless for the American Museum of Natural History to expend more time and money, trying to carry on scientific work under such obstructive conditions. It was unanimously agreed that the Museum should enter into negotiations with the new government of Manchukuo. It was hoped that a more liberal attitude toward international scientific work would be found among the authorities of the new state. Happily, such was the case, and Dr. Andrews was instructed to close permanently the museum headquarters in Peking and return to America until such time as we wish to resume work from the new base.

In the statement of the commission, which you enclosed, you intimate that Dr. Andrews was not empowered to take this action and that the American Museum of Natural History will deplore such a position. In reply, I may say that Dr. Andrews is vice-director, in charge of exploration and research, of the American Museum of Natural History, and has at all times officially represented the American Museum in China. His action was taken upon my instructions.

In regard to the editorial from the *China Weekly Review*, a copy of which you enclose, I must say that it is quite at variance with other editorials from foreign language publications which have been brought to my attention. I would suggest that you refer to the editorials in *Le Journal de Pekin, The Shanghai Times, The Shanghai Evening Post and Mercury, The China Press, The North China Star, The P. & T. Times* and *The China Journal*. It is my opinion, derived from these editorials and from many other sources, that the statement in *China Weekly Review* is by no means a true expression of the opinion existing among foreign residents of China.

The American Museum regrets as much as does your commission that the friendly relations which existed between Chinese scientific men and the American Museum of Natural History until 1928 should be thus severed. Such a condition is most unfortunate from every standpoint. I feel, however, that it has been brought about through no fault of ours. Dr. Andrews insisted upon the privilege of completing our work in Mongolia, which was entered into in 1921 under a definite agreement with the Geological Survey. Apparently this has made him unwelcome to your commission. I can not, however, agree that there was any other course open to him.

You state that your commission "is always ready to promote scientific cooperation if proposed upon a fair and reasonable basis." I feel that the proposals made to you by Dr. Andrews were both fair and reasonable. It is difficult to see how it would be profitable for this museum to conduct field work under any other conditions.

EARTH ROTATION AND RIVER EROSION

UNDER the above title SCIENCE for November 11 contains an interesting article by Professor Herman L. Fairchild. After pointing out the minuteness of the deflective force which arises from rotation of the earth, Professor Fairchild gives briefly the results of an examination of topographic maps for the state of

New York. His study reveals no evidence for any observable effect that can be attributed to rotation of the earth. The steeper right-hand banks of streams on Long Island, which have been regarded as evidence for this effect, he explains by the action of winds. My purpose in this note is to point out in a somewhat different way the kind and amount of the effect which I should expect the rotation of the earth to have on a river.

The force in question is that which is usually connected with the name of the French mathematician Coriolis. When a body moves freely over the surface of the earth in the northern hemisphere the Coriolis force leads to a deflection of its path toward the right. In the case of a river this force acts on all the water in the river, just as gravity does. In the northern hemisphere the result is that the right-hand part of the river is a trifle higher than the left. Any possible greater erosion of the right bank is to be connected with this greater depth of the water, and it does not depend on whether the river is straight or meandering.

It is not difficult to obtain numerical values for the difference in level to be expected on the two sides of the river. When a body is moving north or south the magnitude of the Coriolis force is $2mv\omega \sin \lambda$, where m stands for the mass of the moving body, v for the speed with which it is traveling over the earth, ω for the angular speed of the earth, and λ for the latitude. If the body is moving in any other horizontal direction the force is somewhat greater. When the body moves east or west the sin λ in the above expression is to be replaced by unity. For a river which flows north or south at five miles an hour in latitude 42° the deflective force turns out to be about 0.000,0223 of the weight of the water. If the river flows east or west the force is about 0.000,0334 of the weight.[1]

From a simple composition-of-forces diagram it is easy to see that this same quantity gives the ratio of the difference in levels on the two sides of the river to the width of the river. For instance, if the river is flowing south at five miles an hour and is a hundred feet wide, the difference in levels at the two banks would be less than 0.03 inch, and if the river is half a mile wide the difference would be about 0.7 inch. Any difference in erosion caused by such slight differences in level would doubtless be masked by other agents, so that the results which Professor Fairchild finds are to be expected.

ARTHUR TABER JONES

SMITH COLLEGE

[1] Professor Fairchild quotes Gilbert as quoting Bertrand in saying that for a river running at three meters per second in latitude 45° the force is 1/63,539 of its weight. This value is half what it should be, and was probably obtained by neglecting the factor 2 in the expression for the Coriolis force.

AN ODD OCCURRENCE FOLLOWING A TROPICAL STORM[1]

FOLLOWING the recent hurricane in Puerto Rico a peculiar phenomenon became evident in and about San Juan. The paint of many buildings began to show irregular patches of discoloration, and the intensity of this staining increased with time. The darkened areas were more frequently in positions where contact with water had been prolonged, and had the appearance of being caused by hydrogen sulfide. There were also many reports of the blackening of silver and copper articles in the homes of the city and its suburbs. The same conditions, though to a less extent, occurred in the San Felipe storm of 1928.

The Department of Health believed the results to be due to the action of hydrogen sulfide and offered the suggestion that the gas might have come from a tidal mangrove swamp located just south of the city. In order to test this hypothesis the writers collected several samples of mud from this mangrove swamp. In examining the area, the odor of hydrogen sulfide was noticeable, and 20 liters of air drawn through a glass tube, containing a filtering plug of cotton and then a second cotton plug moistened with lead acetate, gave a positive test by the darkening of the moistened cotton. Lead acetate solution, dropped into the salt water draining from the swamp, showed the characteristic formation of black lead sulfide.

The mud samples, collected over a distance of five miles, gave from 0.09 to 0.35 mgs of free H_2S and from 0.07 to 0.67 mgs of combined sulfides per gram of mud. In one case 380 grams of mud yielded 296 cc of gas calculated to standard conditions. The only conclusion possible is that due to the presence of sewage entering at various parts of the tidal stream that cuts through the swamp, large amounts of hydrogen sulfide are being produced. The hurricane undoubtedly helped to distribute sewage over a wide area and stirred up the mud by swaying the mangrove trees. Possibly the low barometric pressure helped in liberating some gas. The storm was followed by several warm, quiet days with faint land breezes at night that blew from the swamp over the city.

It is, of course, well known that sewage produces appreciable amounts of hydrogen sulfide, but it seems unusual to find a case with such a wide distribution and high concentration in the air as to affect paint and metal objects in a city that extends over six miles in length.

D. H. COOK
CARLOS CINTRÓN

SCHOOL OF TROPICAL MEDICINE
SAN JUAN, PUERTO RICO

[1] From the Department of Chemistry of the School of Tropical Medicine of the University of Puerto Rico under the auspices of Columbia University.

A RARE CRYSTAL HABIT FOR GYPSUM

IN November, 1931, the writer, in company with Professors S. B. Talmage and Evan Just, of the New Mexico School of Mines, and S. G. Lasky, of the U. S. Geological Survey, made a visit to the White Sands in Dona Ana County, New Mexico. To the west of the main body of the sands and east of the San Andres Range, in the heart of the Tularosa Desert, lies a typical, ephemeral, desert soda lake, Lake Lucero. This shallow lake and its surrounding alkali flat are fed at certain times of the year by a small, sluggish stream from the north. Along the banks of this stream, in T. 18 S., R. 5 E., three or four miles northeast of the old Eddy Soda Prospect, were found a number of gypsum crystals, the habit of which is believed to be rare, if not unique.

The writer made some study of the crystals without being able to arrive at a satisfactory conclusion concerning their habit. Some of the crystals were then sent to Dr. A. J. Walcott, of Northwestern University, who reported the habit to be that of a negative hemibypyramid and a basal pinacoid, the latter showing a vicinal formation.

The crystals are tabular and have their greatest dimension along the *b* crystallographic axis. Some of the surfaces, particularly the faces of the basal pinacoid, are much corroded, and the edges in some cases are rounded. Twinning appears to be uncommon, but one contact twin was found showing the twinning plane along the orthopinacoid.

As mentioned above, this habit appears to be rare or unique. At least it was a new habit to the members of this party and to Dr. Walcott. If other mineralogists are familiar with gypsum crystals of this type, the writer will appreciate learning of them.

C. E. NEEDHAM

NEW MEXICO SCHOOL OF MINES

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE SOCIAL SCIENCES AT ATLANTIC CITY

A DISTINCTLY varied program will be presented in the social sciences at Atlantic City. Program plans in anthropology, psychology, history, economics, sociology and education are now complete.

On Tuesday evening, December 27, Professor Franz Boas, of Columbia University, retiring president of the association, will deliver a general address on "The Aims of Anthropological Research." On Wednesday evening, Dr. W. K. Gregory, American Museum of Natural History, retiring vice-president for Section H (Anthropology) will speak on "The New Anthropogeny: Twenty-five Stages of Vertebrate Evolution from Silurian Chordate to Man." Sessions for the reading of papers on anthropological research will be held, beginning Wednesday and extending through Friday, December 30. Professor J. Alden Mason, of the University of Pennsylvania, is expected to present some interesting new material on the relations between the Indian cultures of Mexico and the Mississippi Valley. Dr. J. Spinden, of the Brooklyn Museum, will exhibit some pre-Columbian manuscripts of Southern Mexico, and Dr. Aleš Hrdlička, of the U. S. National Museum, will describe the 1932 anthropological explorations in Alaska. Dr. George Grant MacCurdy, director of the American School of Prehistoric Research, will show lantern slides exhibiting the latest Old World discoveries of fossil man. On Saturday morning, the American Anthropological Association and Section H will join with the historical and philological section for a symposium on "Primitive Languages." (For details of this symposium and others see SCIENCE, November 11.)

The psychological section plans sessions from Wednesday morning, December 28, to Friday afternoon, December 30. At a joint session with the educational section on Wednesday evening the addresses of the retiring vice-presidents for the two sections will be given. Professor Herbert S. Langfeld, of Princeton University, retiring vice-president of Section I (Psychology) will speak on historical development in response psychology, and Professor Ernest Horn, of the University of Iowa, retiring vice-president for Section Q (Education) will speak on science and the problem of value. On Wednesday afternoon problems of old age will be discussed by Professor Walter R. Miles and Catharine Cox Miles, of Yale University, by Dr. David Wechsler, of Bellevue Hospital, New York, and by Professor John E. Anderson, of the University of Minnesota. On Thursday afternoon Miss Myrtle B. McGraw, of the Babies Hospital, New York City, and Dr. E. A. Doll, of the Training School at Vineland, New Jersey, will show motion pictures in a symposium on "Mental Development." Miss McGraw will also speak on outstanding phases in the development of specific traits of infants during the first year of life, and Dr. Doll will speak on the psychological significance of cerebral birth lesions. Twenty-seven other psychological papers will be presented on a wide range of subjects, including tests and measurements, responses, behavior patterns, reliability and cheating, psychoneuroses and others.

Section Q (Education) will begin its program on

Tuesday morning, December 27. At the first session Professor Arthur B. Moehlman, of the University of Michigan, will present a study of teacher supply and demand. Other experimental studies of general educational problems will be described by Professor E. D. Grizzell, Professor L. A. Pechstein and Professor Norman M. Grier. The Tuesday afternoon session of Section Q will be devoted to experimental studies of collegiate education, and the Wednesday morning session will be devoted to experimental studies of elementary and secondary education. On Wednesday afternoon there will be a symposium on "General Problems of Education." Professor E. R. Hedrick, of the University of California at Los Angeles, will speak on cooperation in educational problems. Professor W. B. Carver, of Cornell University, will discuss substitutes for thinking in the study of mathematics. Professor F. K. Richtmyer, of Cornell University, will speak on "Physics is Physics," and Professor Harry A. Cunningham, of Kent State College, will discuss science laboratories in teachers' colleges. A session devoted to miscellaneous educational problems will be held on Thursday morning.

The program of Section K (Economics, sociology and statistics) will be more varied than usual and will be devoted to sessions on sociology, statistics and econometrics. At the first session of Section K and the Econometric Society, which will be held on Monday evening, December 26, papers on economic theory will be presented by Professor H. T. Davis, of the University of Indiana, and Professor Edward Thiess, of the Technical University of Hungary. Professor W. F. Ogburn, chairman of Section K, will preside at a session on sociology Tuesday morning, December 27, and will present a paper. Other papers on sociology will be presented by Charles A. Ellwood, Dorothy S. Thomas, F. Stuart Chapin, Robert Faris and Wilson Gee.

On Tuesday morning there will be also a joint session with the American Mathematical Society for the reading of papers on mathematical statistics. Dr. W. A. Shewhart, of the Bell Telephone Laboratories, and Dr. Max Sasuly, of the Brookings Institution, will present papers at this session. Tuesday afternoon will be devoted to miscellaneous papers on statistics, economics and sociology. At 4:30 Tuesday afternoon a joint session will be held with the Mathematical Association of America. At this session Professor G. C. Evans, of the Rice Institute, retiring chairman of Section K, will speak on "The Theory of Money."

All day Wednesday Section K will meet with Section M (Engineering) for a symposium on "The Stabilization of Employment." At this session papers will be presented by Gerard Swope, Irving Fisher, John Lyle Harrington, Leo Wolman, Dugald C. Jackson, Alvin Hansen, C. F. Kettering, H. L. Rietz, K. T. Compton, Elmer J. Working, Walter Rautenstrauch, Royal Meeker, James W. Angell and W. N. Loucks. (See SCIENCE for November 11.)

CHARLES F. ROOS,
Permanent Secretary.

THE NATIONAL ACADEMY OF SCIENCES

PAPERS PRESENTED AT THE ANN ARBOR MEETING. II

(*Continued from page 522*)

Some aspects of neurohumoralism: GEORGE H. PARKER. By a small transverse cut in the tail of a fish the chromatophores posterior to the cut may be denervated. Such denervated areas become light or dark under appropriate environments but more slowly than the surrounding skin. These slower changes are due to the transfusion of neurohumoral substance from the adjacent changed areas. The rate of transfusion is such that the process must be regarded as cellular and not due to lymph or blood currents. Layers of cells thus form transmitting systems in contrast with lymph and blood. This is common in coelenterates, but, as the example shows, the process also occurs in higher forms.

How the primitive ants of Australia start their colonies: WILLIAM MORTON WHEELER. See p. 532.

Time of embryonic segregation in aphids as determined from intermediate types: A. FRANKLIN SHULL (introduced by F. G. Novy). Nearly twice as great a proportion of the intermediates between gamic and parthenogenetic aphids are of the sorts required by the time-of-segregation theory as could be accounted for by mere random combination. Nevertheless, nearly one fourth of the total number do not fit that theory without modification. To explain these exceptional forms in harmony with the theory requires that the time of segregation be frequently irregular or that there be a rapid fluctuation of the physiological level which constitutes the "turning-point" of development or that the thresholds of stimulation of the several parts vary greatly. The accumulation of the regular or expected intermediates near the gamic extreme has received no satisfactory explanation.

The distribution of birds in northern Guatemala: JOSSELYN VAN TYNE (introduced by F. G. Novy). The Museum of Zoology of the University of Michigan undertook two years ago to cooperate with the Carnegie Institution of Washington in a survey of the Maya area of Central America, this survey to extend over a number of years. The Museum of Zoology is responsible for the biological phase of the survey. The first field party from the Museum of Zoology accompanied the Carnegie Institution's archeological expedition to Uaxactun in northern Guatemala, and researches made on these collections are the basis for certain zoogeographical con-

clusions outlined in this paper. In very brief, it may be said that the climate of the Yucatan Peninsula, of which northern Guatemala forms the base, is marked by aridity, increasing to the northward and reaching a maximum at the tip of the peninsula. Surrounded on three sides by the ocean and cut off on the south by the humid rain-forest, it is biologically in some respects an island. The avifauna is relatively poor in number of species but is a very interesting one. It is composed of four principal elements, as follows: (1) Certain endemic genera and species, clearly relicts of a very ancient fauna. (2) A small tropical rain-forest element derived from the Caribbean slope of Central America. (3) An arid tropical element which ranges up the Pacific coast of Central America and reaches Yucatan by way of the Isthmus of Tehuantepec. (4) A boreal element derived from North America and found mainly in the "pine ridge" areas at the base of the peninsula.

Some problems of the Hawaiian flora: DOUGLAS H. CAMPBELL. A study of the plants of the Hawaiian Islands is of interest not only to the botanist, but to the geologist and geographer, owing to the remoteness of the archipelago, and the relationships of the plants to those of other regions. The extreme isolation of Hawaii is reflected in the remarkable percentage of endemic species, the greatest known. The theory which has been advanced, that the islands are the result of submarine volcanic activity and have always been completely isolated, is not supported by a critical examination of the plants. It is quite impossible to account for the majority of these as having been introduced from outside. To account for the predominance of forms whose nearest relatives belong to the Southern Pacific regions, *e.g.*, New Zealand, Australia and Malaya, we must assume the former existence of land connections between Hawaii and these southern regions. Both the remoteness of these regions and the character of the plants make it impossible that they could have reached the islands by any means of transport over the ocean. The Hawaiian archipelago comprises over 6,000 square miles; the most completely isolated area of equal size in the world. The nearest mainland, North America, is over 2,000 miles distant. Between the islands and the Pacific Coast, there are agencies, *viz.*, N. E. trade winds, ocean currents and migrating birds, which are sufficient to account for the American elements in the flora; but a very much larger number have no American relationships.

Host specialization of Erysiphe graminis tritici: EDWIN B. MAINS (introduced by F. G. Novy). A study of the wheat race of the powdery mildew of grasses, *Erysiphe graminis tritici*, has resulted in distinguishing two physiologic forms of the mildew, which differ rather markedly in their ability to develop in several wheat varieties. Inoculation of a rather extensive series of wheat varieties with physiologic form 1 has shown that these varieties can be divided into a number of groups according to their mildew reaction. The majority were susceptible. Fewer were moderately susceptible or moderately resistant. The varieties, Norka (C. I. 4377), Dixon (C. I. 6295), Huron (C. I. 3315), Red Fern, Sonora (C. I. 4293), Chul (C. I. 2227), Axminister (C. I. 1839), Erivan (C. I. 2397), Khapli (C. I. 4013), Yaroslav (C. I. 1526), Vernal Emmer (C. I. 1524), Emmer (S. D. 293), Einkorn (C. I. 2433) and several selections of Illinois No. 1 were outstanding for their pronounced resistance. The varieties Hope (C. I. 8178), Progress (C. I. 6902), and Michigan Amber (29–1–1–1) varied considerably in their reaction. Physiologic form 2 of the mildew has been studied on fewer varieties, mostly those resistant to physiologic form 1. It can be distinguished from the latter by the reactions of a number of the varieties. Norka (C. I. 4377), however, most sharply differentiates it, being very resistant to physiologic form 1 and very susceptible to physiologic form 2. The varieties Dixon (C. I. 6295), Red Fern, Sonora (C. I. 4293), Khapli (C. I. 4013), Vernal Emmer (C. I. 1524), and Illinois No. 1, selections 35, 47 and 59, were specially outstanding for resistance to both physiologic forms of the mildew. (Investigation started through the cooperation of the Purdue Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry and continued at the University of Michigan.)

In vitro experiments on the metabolism of the pancreas: EUGENE U. STILL (introduced by A. J. Carlson). The metabolism of the resting and active pancreas of dogs under barbital anesthesia has been studied. The rate of blood flow through the pancreas was measured continuously, samples of arterial and venous blood (from the pancreas) were taken during the resting state for O_2 and CO_2 analyses. Samples were also collected during and after maximal secretion by the pancreas (Secretin stimulation). The data indicate: The R. Q. of the resting gland is between 0.70 and 0.80, and for the active gland about 1.00. The oxygen consumption of the pancreas increases rapidly with the onset of secretion and develops a large oxygen debt which is not dissipated until some time after the secretion has stopped. The carbon dioxide production of the gland (corrected for the CO_2 in the juice) increases rapidly during activity and gradually returns to the resting level somewhat before the oxygen consumption. The data indicate that during secretion the metabolic CO_2 of the gland is caused to pass into the juice instead of into the blood. In some experiments the juice contained 7 times as much bicarbonate as the blood. The mechanism of this phenomenon is under investigation.

On a laboratory method of testing the potency of liver extract: CHARLES W. EDMUNDS (introduced by F. G. Novy). The present research is concerned with an effort to find some method for the laboratory estimation of the potency of liver and stomach preparations which are used in the treatment of pernicious anemia. At the present time no method is known except to observe their effects when they are administered to patients with pernicious anemia. In the present research an effort was made to utilize the changes which are produced in

pigeons' blood by the administration of various liver preparations. The administration to pigeons of such preparations known to be clinically potent is followed in from eight to ten days by an increase in reticulocytes, this increase ranging from about 10 per cent. to even as high as 50 per cent. Preparations of liver which have been rendered clinically inert by means of prolonged heating were also tested as controls, and these proved to be inactive. When they were administered to pigeons no increase in reticulocytes was found. Ventriculin given in capsules had the same effect as had liver preparations. It is believed that this method can be used for the commercial testing of such preparations and also as an aid in the isolation of active fractions of both liver and stomach preparations.

Hemodynamic and respiratory changes following the manipulation and traction of the gastrohepatic ligament: ARNO B. LUCKHARDT, RUTH ALPERT and SIDNEY SMITH (introduced by A. J. Carlson). It is quite commonly known by surgeons that manipulation, including traction of the gastrohepatic ligament, may induce not only a spasmodic intermittent type of respiration but alarming drops in blood pressure. It is generally believed that these hemodynamic and respiratory phenomena are of reflex origin, resulting from stimulation of afferent sensory fibers present in the gastrohepatic ligament or more particularly about the biliary passages. The decrease in blood pressure is considered to be due to reflex vasodilation or reflex inhibition of the general vasoconstrictor tone. In some preliminary experiments it was found that this interpretation is for the most part incorrect. In dogs under ether anesthesia traction on the gastrohepatic ligament produces in most animals an irregular respiration or even complete cessation of respiration if a constant and steady traction is performed. There occurs simultaneously a drop in the blood pressure. However, similar downward traction on the liver, stomach and diaphragm effects the same result, even to a more marked degree. If the hand is simply placed between the liver and diaphragm so that the hepatic veins and inferior cava can be at any moment compressed between the index and third fingers a profound drop in the blood pressure occurs with no change in the respiration rhythm. Each of the maneuvers cited above interferes more or less with the normal return of the venous blood from the splanchnic region and lower extremities. Simultaneous temporary ligation of the portal veins and inferior vena cava within the abdominal cavity causes an identical drop in blood pressure. The abrupt elevation to the normal level on release of the venous obstruction or cessation of traction on the liver, gastrohepatic ligament, stomach and diaphragm indicates that the drop in pressure in each case was not due to the vasomotor reflex but was the result of partial or complete mechanical obstruction. With respect to the spasmodic type of respiration or actual inhibition, it can be shown that the reflex effects seen are due to stimulation of the vagus fibers in the lungs. Each of the aforesaid maneuvers leads to an enlargement of the thoracic cavity with filling and stretching of the lungs. A momentary or more or less prolonged vagal apnoea results; for the irregular, spasmodic respiration fails to occur, following traction on the structures mentioned, if both vagi nerves have been sectioned previously. Briefly, then, the respiratory irregularity on traction is due to stimulation of the vagal nerve endings, resulting from a filling and stretching of the lungs; the hemodynamic phenomena are the result of mechanical interference with the return of venous blood to the heart. These observations do not imply that reflexes from the gastrohepatic ligament are impossible.

The crystalline structure of insulin: GEORGE L. CLARK and KENNETH E. CORRIGAN (introduced by W. A. Noyes). It has been known for some time that insulin exhibited certain optical properties of a true crystal. Although numerous attempts have been made by Freudenberg and others, no x-ray diffraction pattern could be obtained beyond the usual ring due to the 3.5 A. U. spacing common to proteins. Work of this kind employing the usual wave-length of x-radiation, copper (K, 1.54 A. U.), has been carried on in this laboratory for more than two years. Insulin has now been investigated by means of long wave x-rays, using the K α radiation of magnesium (9.86 A. U.). The apparatus, consisting of an x-ray tube and camera built into one unit, will be described. A crystal diffraction pattern was obtained corresponding to unit cell dimensions of 130, 100 and 80 A. U. The crystal is monoclinic, and upon the basis of a molecular weight of thirty-five thousand, there are 24 molecules per unit cell. The extreme complexity of insulin is shown by the fact that the unit cell dimensions are the largest thus far recorded for any substance.

Regeneration in mutilated seedlings: CARL D. LARUE (introduced by F. G. Novy). (Read by title.)

A study of specialization in ring-neck snakes: FRANK N. BLANCHARD (introduced by F. G. Novy). (Read by title.)

Biological inductions from the mechanical evolution of the proboscidea: HENRY FAIRFIELD OSBORN. (Printed in SCIENCE, December 2, 1932.)

The relation of water regulation to habitat selection of reptiles: G. KINGSLEY NOBLE and E. R. MASON (introduced by Henry Fairfield Osborn). Lizards adsorb moisture through their skin, and forms such as Amphisbaena and Eumeces will die from desiccation if they are deprived of a damp substratum for several days. Lizards living in damp habitats lose and absorb greater amounts of water than do those frequenting arid regions. Burrowing lizards have a more permeable skin than surface species have. The arboreal Anolis and the nocturnal Hemidactylus also practice a rapid exchange of water. There is little correlation between water loss and skin structure, except that the most impervious skins are provided with the thickest horny layer. Unlike lizards, the snakes absorb very little water through their ventral

surfaces. With an increase in environmental temperature, the rectal temperature of lizards and snakes is depressed. All lizards, except certain gekkonids, depress more after water is taken in through the mouth or the skin. Species differ both in ability to depress and in temperature tolerance. Survival at high temperatures is dependent on both factors. The rectal temperature of the brooding lizards Eumeces and Ophisaurus follows closely that of the environment. Eumeces voluntarily leaves the eggs at intervals to raise the body temperature by exercise and by sunning. In the laboratory this increase averaged 1.3° C. On returning to the eggs the female aids their incubation by increasing their temperature.

Skull of a fossil bird from the Bad Lands of South Dakota: ALEXANDER WETMORE and ERMINE C. CASE (introduced by F. Leverett). This paper announces the discovery of the skull of a hawk of the genus *Buteo* in the Oreodon zone of the Oligocene beds in the Big Bad Lands of South Dakota. It is the first discovery of bird remains in the locality and carries the genus *Buteo* as far back as the Oligocene; it demonstrates the antiquity of origin of certain still living forms of birds. The excellent state of preservation of the fragile skull is remarkable among fossils of birds.

Miniature rock fans and pediments: DOUGLAS JOHNSON. The origin of erosion planes in arid regions presents a problem of much geomorphic importance, involving as it does divergent interpretations of arid processes and arid forms. Whether these planes are the product chiefly of weathering back of mountain fronts, of sheetflood erosion or of normal stream erosion, involving much lateral planation, is at least far from obvious. The author has suggested the latter explanation and has described rock surfaces of fan form which seem to him normal marginal features of desert rock planes and best explained as the product of stream corrasion. Examination last summer of small scale erosion forms in the Bad Lands of South Dakota revealed the extensive development of miniature rock fans coalescing to form rock pediments or planes. The distribution of these features in relation to drainage lines and their delicate adjustment to miniature stream profiles, seem to exclude the weathering hypothesis, to render the sheetflood interpretation of doubtful application and to favor the ascription of these forms to normal stream erosion. Examples of the miniature fans and pediments are reproduced by the aid of lantern slides and the significance of these small-scale forms to larger problems of the arid landscape is discussed.

Planktonic faunas of the Paleozoic seas of North America: RUDOLF RUEDEMANN. (Read by title.)

Further aerological studies near the margin of the Greenland Continental Glacier: WILLIAM HERBERT HOBBS (introduced by F. Leverett). The University of Michigan has now sent five expeditions to Greenland for the primary purpose of investigating by aerological methods the nature of the wind system over and about the Greenland continental glacier. These expeditions have been sent out in 1926, 1927, 1928, 1929–30 and 1932–33. The results have already revealed much concerning the structure of the glacial anticyclone, the northern wind pole of the earth. The paper outlined results of the work of the Fourth Expedition (1929–30) and the plans of the Fifth Expedition, which is now in Greenland.

Problem of motor fuel quality: GEORGE G. BROWN (introduced by M. Gomberg). (Read by title.)

Report on Senate Bill 2778: GEORGE O. SQUIER.

The surface configuration of a part of southeastern Brazil: PRESTON E. JAMES (introduced by F. Leverett).

A new interpretation of drainage shiftings in Ohio: FRANK LEVERETT. It has long been known that the preglacial drainage of much of the Ohio was northward into the Erie Basin along lines now followed by Grand, Cuyahoga and Sandusky rivers. The early Quaternary glaciation blocked this drainage, but did not initiate the present drainage. Instead, much of the Muskingum as well as the Scioto had discharge down the Scioto valley to Portsmouth, and from there down the Ohio. The Illinoian glaciation blocked the westward discharge of the Muskingum drainage, and diverted it from the Scioto Basin to its present southward course into the Ohio at Marietta. The new interpretation of the interglacial course down the Scioto is sustained by the slope of the rock floor as shown by deep borings. There is also a strong presumption that a considerable part of the old Monongahela system, which in preglacial time drained western Pennsylvania and adjacent parts of West Virginia and Ohio into the Erie Basin, returned to that basin when the ice of the early Quaternary glaciation had disappeared. There is some evidence from well borings of an interglacial gorge cut in the preglacial valley floor in northeastern Ohio, whose bed slopes toward Lake Erie. But more decisive evidence that the interglacial flow was not down the present Ohio is found in remnants of a small interglacial channel along the Ohio downstream from where this drainage system led away. The present large river may have been established no earlier than the Illinoian glacial stage.

Minnesota Pleistocene Homo: A. E. JENKS (introduced by Frank Leverett). On June 16, 1931, a road crew, working on highway No. 30 in Ottertail County, Minnesota, found and removed a human skeleton from 2.3 feet beneath the road surface and 9 feet, 9 inches beneath the ground surface as surveyed and plotted by the State Department of Highways before the cut for the new roadway was begun. On May 7, 1932, the site was redug for identification in the presence of Dr. Stauffer, Dr. Thiel, Dr. Butters and Dr. Jenks, of the University of Minnesota. Seven additional fragments were found. From August 2 to 7, 1932, the site was extensively dug out by Dr. Jenks and six students, when 355 additional fragments were obtained. The skeleton was rescued

from the silt of an extinct glacial lake, first noted by Dr. Frank Leverett and published by him in 1914. The date is placed by the same authority as about 20,000 years ago or before even the first stage of Glacial Lake Agassiz. The site has been carefully studied by Dr. Stauffer and Dr. Thiel, Minnesota geologists, who concur in Dr. Leverett's findings. The skull is of a nature to suggest an early dating, aside from the geological evidence. It is of a generalized type of *Homo sapiens*, showing distinct Mongoloid affinities. The teeth are unusually large and retain certain features of still earlier mankind. The rounding of the borders of the nasal opening is extraordinary and is strongly reminiscent of conditions seen in anthropoid apes. The extreme narrowness of the nasal opening, together with its lack of lower borders, and with its rudimentary spine, stamp this skull as a most unusual specimen.

(To be concluded)

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ADJUSTABLE METAL MOULD FOR PARAFFIN EMBEDDING

THE mould described here is unlike any of the types more or less commonly used, such as folded paper boxes, glass dishes and the adjustable metal moulds consisting of L-shaped bars for sides and a flat plate for bottom. It (see Fig. 1) consists of two metal

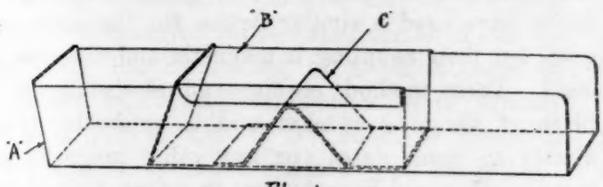


Fig. 1

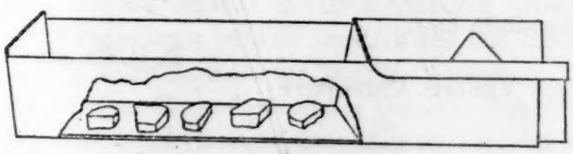


Fig. 2.

troughs, A and B, both open at one end. Trough B fits snugly into trough A, closing its open end, and so forms a trough closed at both ends, easily adjustable in length by simply sliding B either to or from the closed end of A. The sides of both troughs slope outwardly, as also do the closed ends when the two troughs are fitted together to form the mould. The upper portions of the sides of trough B are folded over outwardly and, when B is in position as one end of the mould as shown in the figure, engage the upper portions of the sides of trough A, thus holding trough B securely in place anywhere within the working length of the mould. A folded metal strip C serves as a finger piece for conveniently adjusting the size of the mould. The dimensions of the mould from which the figures here shown were drawn are: Trough A, length 6 inches, inside width at bottom 1 inch, at top 1⅛ inch, depth 1 inch; trough B, length at bottom 2½ inches, other dimensions such as to fit snugly within trough A. Moulds of different dimension, of course, are simply matters of particular wants and individual preferences. As evident from the description and the figures, the sides and ends of castings from this mould will be plane surfaces sloping towards the bottom, or face, of the castings, a shape that will be appreciated when trimming them either before or after fastening them to the cutting platform of the microtome. From its constructional features, this mould has been found peculiarly well suited for specimens that are to be located in some particular plane or axis and, also, for such specimens as may be difficult to locate in castings when surrounded by considerable masses of paraffin, for instance, protozoa and scrapings of tissues. The mould can be narrowed in one axis and so adjusted that the specimens are enveloped on two sides by a minimum thickness of paraffin, while the sloping sides and ends afford a good view and easy access in arranging the specimens on the bottom of the mould, or face of the casting. In the case of very small bodies, such as Protozoa, the sloping sides of the mould focus them, so to speak, on the face of the casting. With small visible bodies the thin bar or edge of the semi-transparent paraffin permits them to be more or less clearly seen and properly located on the cutting platform of the microtome. As a permanent device, this mould saves both loss of time and minor inconveniences attendant on the making and using of paper box moulds; compared with the adjustable L-shaped metal moulds, because of its construction it is not subject to leakage of paraffin caused by dislocation of its parts by jars or other accidents, not infrequent occurrences with the L-shaped bars of such adjustable moulds.

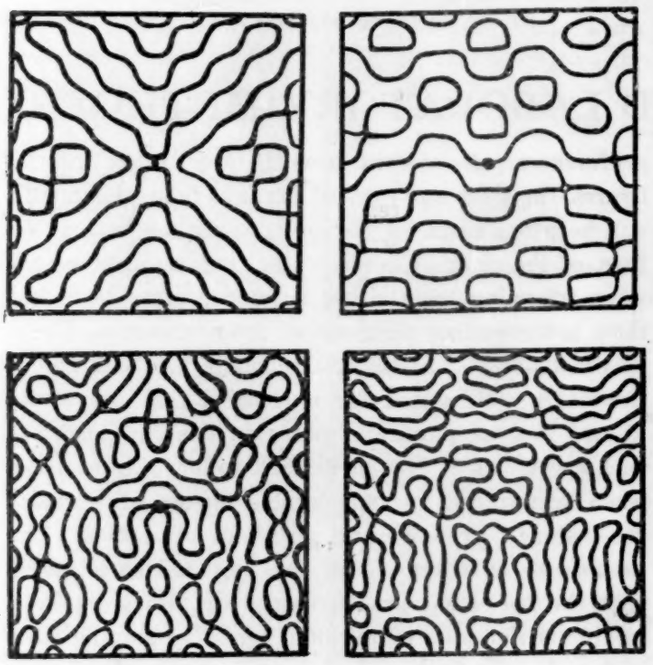
Should the mould herein described appeal to other workers with paraffin, information regarding it may be had of The Arthur H. Thomas Company, Philadelphia, Pa.

W. F. R. PHILLIPS
MEDICAL COLLEGE OF THE STATE OF SOUTH CAROLINA

A VACUUM TUBE OSCILLATOR FOR CHLADNI PLATES

THE three-element vacuum tube used so extensively in radio telephony may be made to act as a detector,

an amplifier or an oscillator, depending upon the circuit in which it is connected. As an oscillator, it will give out vibrations varying from several a second to millions a second. The lower or audible vibrations of a triode valve are produced by connecting the valve with a large inductance and capacity. Several years ago, it occurred to the writer that a valve oscillator



might be used to vibrate Chladni plates and so produce sand figures which had not been found before. The triode valve is connected in a circuit so as to produce audible notes from four to twelve kilocycles per second; both the inductance and the capacity are variable. The note from this circuit is passed into a power amplifier and thence into a telephone receiver or an electrodynamic loud speaker. One type of the complete set-up is illustrated in another article to which the reader is referred.[1] The vibrating member of the loud speaker is mechanically coupled to the Chladni plate by a small metal rod, one end of which is rigidly attached to the center of the vibrating diaphragm, while the other end is pressed against the underside of the Chladni plate. This connection corresponds to "loose coupling" in radio circuits. Sand is strewn upon the plate and the note changed by means of the variable condenser; when a suitable note is reached, the plate oscillates vigorously and nodal lines are formed. With this instrument, thin plates may be vibrated at high frequencies, thus producing extremely complicated but regular patterns. A few of these are shown in the figure. Andrade and Smith have used a similar device for the same purpose, but their coupling is magnetic and not mechanical.[2] Their method requires an electromagnet in place of the loud speaker and is applicable immediately to steel plates (or any other magnetic material). It would be necessary to attach a small steel button to a brass plate before the magnetic field could set it in vibration. Either method is an improvement on the violin bow.

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SPECIAL ARTICLES

THE ARSENIC FUNGI OF GOSIO[1]

REFERENCES to poisoning in some way attributable to arsenic in coloring substances used upon wall paper, hangings or in carpets, or as a component of certain paints, began to appear about 1815. In the later years of the nineteenth century, such poisoning began to be correlated with the presence of arsenical gases such as arsine and with moldy conditions in the buildings in which the cases occurred. Then Gosio,[2] in 1892, demonstrated in laboratory experiments that certain fungi called by him the "arsenic fungi," were capable of setting such gases free, by their action upon compounds of arsenic.

The biochemical experiments of Gosio were accepted generally as showing that at least part of these poisoning cases were due to arsine or some other volatile compound of arsenic, produced by moldy areas in the rooms occupied by those injured. The exact nature of the gases produced seems still to be debatable and is under investigation by the insecticide division of this bureau. Maasen[3] restudied the biochemistry of Gosio's organism, *Penicillium brevicaule*, and drew distinctions between the gases produced by its activity upon arsenic, selenium and tellurium. By 1914, the number of studies had so increased that Huss included fifty-five titles in his bibliographic survey. Since that time comparatively few studies of this kind have been reported, and apparently very few

[1] This article is No. 1027 of the outside publication series of the Bureau of Chemistry and Soils.

[2] B. Gosio, "Azione di alcune muffe sui composti fissi d'arsenico," in *Rivista d'Igiene e Sanita Pubblica III*, (8/9): 201–230 and 261–273, 1892.

[1] *Phil. Mag.*, Vol. XII. Suppl., Aug., 1931, p. 320. See also *Jour. Franklin Inst.*, Aug., 1932, p. 199.

[2] Andrade and Smith, *Proc. Phy. Soc.*, 43, pp. 405–411, July, 1931.

[3] Albert Maasen, "Die biologische Methode Gosio's zum Nachweis des Arsens und die Bildung organischer arsen-, Selen-, und Tellurverbindungen durch schimmelpilze und Bakterien," *Arbeiten aus dem Kaiserlichen Gesundheitsamte*, 18 (1): 475–489, 1902.

cases of poisoning from this source have been recognized.

Recently (*The Analyst*, March, 1932) Lerrigo[4] in England has reported two deaths attributed to arsenic, which was found by analysis of the body tissues. Epidemiological studies disclosed that the room in which the cases developed had moldy walls, which, when removed and analyzed, contained considerable quantities of arsenic. Arsenical odors were reported. Further proof of cause of death was not offered. This report lead Dr. C. A. Browne, assistant chief of the Bureau of Chemistry and Soils, to call our attention to the lack of published surveys of the so-called arsenic fungi in America and of their possibilities of harm.

It was a simple matter to inoculate arsenic-containing media with *Penicillium brevicaule* from our own culture collection and demonstrate the production of ill-smelling arsenical gases. Undertaking to follow this series of reactions to the field and to test their significance in America led to experiments in two directions: (1) Survey testing of stock cultures of molds whose habit and significance were already known, and (2) studies of the effect of arsenical dusts and sprays upon the microflora of the soil.

(1) For the survey tests 0.1 and 0.15 per cent. of arsenic, calculated as arsenious oxide, were added to Czapek's solution agar. In these cultures fifteen species of Penicillium proved negative (as had those reported by Huss[5]), with the possible exception of a feeble reaction from *P. duclauxi* Delacr. Twenty-two strains of Aspergillus, representing the taxonomic groups established by Thom and Church, furnished two active species, *A. fischeri* Wehmer and *A. sydowi* Bainier and Sartory, with only traces of arsenical gas from *A. fumigatus*, one of the *A. glaucus* group, and two of the *A. ochraceus* group. Our strains of the other genera reported positive by Huss and Gosio proved negative. In subsequent cultures ten strains or species of Scopulariopsis (the *P. brevicaule* series of older authors) were all active gas producers. Fourteen strains of *Aspergillus sydowi* were positive. Species of both of these groups are common in soil and in many other substances. Many of the organisms tested refused to grow at the arsenic concentration used and will be tested at lower concentrations later, hence some of the organisms, thus far found negative, may be in fact gas producers.

A number of other common aggregates, such as *Penicillium expansum, P. chrysogenum, P. roqueforti* and their allies, *Aspergillus flavus, A. oryzae* and the whole cosmopolitan group to which they belong, one species of Helminthosporium and an occasional Mucor grew well upon the arsenical substrata without producing ill-smelling gas. These may be called arsenic tolerant.

(2) For soil studies, Mr. W. B. Albert, of Florence, South Carolina, furnished samples of *Durham coarse sandy loam*, from the plots already discussed by Paden and Albert[6] as containing enough arsenic to prevent normal growth of certain crops. Mass cultures were first made to get a survey of the species of mold present. The Scopulariopsis or *P. brevicaule* group of species was not represented. A few colonies of green Penicillia and one or two colonies of Aspergillus developed. About two species of Fusarium and two or three sterile forms producing brown to black masses of mycelium, were the most abundant molds. Many colonies of Actinomyces were seen. Colonies of bacteria grew freely. Myamoebae and eventually one plasmodium developed upon mannite agar. No infusoria and no nematodes were seen.

Dilution cultures from the same soil upon arsenic agar (Czapek's solution agar with arsenic), showed the same species. Arsenical gas was detectable in all the petri dishes. Two strains of Fusarium, at least one sterile brown fungus, and one strain of Paecilomyces, when isolated and tested separately, were active gas producers. *Aspergillus ustus*, the Penicillia and some of the brown forms present were negative. The Actinomycetes and bacteria present have not yet been studied.

The species active do not appear, either from the literature (Gosio, Maasen, Huss and others) or from our experiments, to be exacting as to the form of arsenic compound presented. Some commercial "arsenicals" and some commercial products to which arsenic compounds have been applied as preservatives have been tested and found positive. These results agree with Huss' statement that some at least of these fungi will evolve arsenical gas from any arsenic compound presented.

The use of arsenical preservatives for manufactured products, particularly forest products, has been commercially developed and reported (Curtin)[7] to be effective for certain trade purposes. This literature has been reviewed only far enough to show that the possibilities of activity on the part of the "arsenic fungi," with the attendant production of noxious gases, are not discussed by them. Our own prelimi-

[4] A. F. Lerrigo, "The Biological Method for the Detection of Arsenic," *The Analyst*, 57 (672): 155–158 and 163–4, 1932.

[5] H. Huss, "Zur Kenntnis der biologischen Zersetzung von Arsenverbindungen, *Ztsch. f. Kyg. u. Infektionskrankheiten*, 76 (3): 361–406, 1914.

[6] W. R. Albert and W. R. Paden, "Calcium Arsenate and Unproductiveness in Certain Soils," SCIENCE, 73 (1901): 622, 1931.

[7] Leo Patrick Curtin, "Experiments in Wood Preservation. II—Arsenites of Copper and Zinc," *Ind. Engr. Chem.*, 19 (9): 993, 1927.

nary experiments indicate that the "arsenic fungi" will readily attack some of the arsenites used.

Certain conclusions are indicated:

(1) Arsenic fungi are more numerous than was previously supposed. Some saprophytic species common in the soil are active in the production of arsenical gases.

(2) Arsenic tolerant forms include many species which do not decompose arsenic compounds with the evolution of gases.

(3) Arsenical substances carried to the soil come in contact with decomposing agents, which tend to break them into volatile or quickly soluble forms. Accumulation of arsenic in the soil may be expected to occur only when massive amounts are used or under special conditions unfavorable to the development of a varied microflora.

(4) The disintegration of arsenical compounds may be caused by a considerable variety of fungi. Presumably, therefore, it is of sufficiently common occurrence to warrant the avoidance of arsenical preservatives for materials to be utilized in enclosed areas.

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WORK OUTPUT OF RATS SUBJECTED TO CONTINUOUS FARADIC STIMULATION

IN a preliminary study of work output in intact, anesthetized animals, using methods described below, it is possible to produce periodical muscular contractions for long periods of time.

Previous studies on rats and other animals have been supposed to demonstrate that skeletal muscle can be completely fatigued in a relatively short time. By the use of modified methods, however, in which the gastrocnemius muscle is subjected to faradic stimulation, it is possible to maintain a high level of work output for upwards of ten days, during which time the muscle lifts a 100-gram weight at the rate of three times per second. At the end of this time it is necessary to suspend experimentation because of complicating factors, such as general emaciation, edema, infection and other conditions of the muscle.

Although some decrease in output is noted throughout the work period it is believed that the complicating factors mentioned above are in large measure responsible for the more pronounced decrease observed near the end of the experimental period. At no time, however, does the working muscle show signs of complete fatigue. On the contrary, a fair level of output is maintained up to the time the animals are removed.

The total amount of work, as calculated for each animal by the aid of an automatic recording device, is found to range between 105,000,000 and 177,000,000 ergs. This is only a rough approximation, however, since such factors as friction and inertia have not been allowed for in making the calculation.

In so far as the writers have been able to determine, both the time and work records obtained are considerably greater than any previously reported. It is believed that this greater amount of work is due primarily to differences in method employed. In trying various methods it was found, for example, that activation of the muscle by stimulating the peripheral portion of the severed sciatic nerve was accompanied by dying of the nerve, a rapid loss in muscle irritability and consequently a shortened work period. This shortened work period or supposed "fatigue" proved therefore to be an artifact of the dying of the nerve and did not give a true picture of the muscles' capacity for energy output.

It was further found during the course of the investigation with both the direct and indirect methods of stimulating the muscle that the work output varied considerably with differences in the type of shock used, such as changes in amperage and voltage, frequency and time relations of the stimuli and the direction of the flow of current.

The methods and apparatus used and the results obtained in the present study will be reported in detail in a later paper.

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W. J. INGLE
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BOOKS RECEIVED

BARTLETT, F. C. *Remembering.* Pp. x + 317. Illustrated. Macmillan. $5.00.

BROWN, A. E. *Workbook in Elementary Psychology.* Pp. iii + 182. Macmillan. $1.25.

EMMONS, WILLIAM H., GEORGE A. THIEL, CLINTON R. STAUFFER and IRA S. ALLISON. *Geology.* Pp. xii + 514. 478 figures. McGraw-Hill. $4.00.

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